(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
19 September 2002 (19.09.2002)

PCT

(10) International Publication Number
WO 02/074017 A1

(51) International Patent Classification⁷: H05B 33/08

(21) International Application Number: PCT/GB02/00963

(22) International Filing Date: 11 March 2002 (11.03.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0105992.2 10 March 2001 (10.03.2001) GB
0108667.7 6 April 2001 (06.04.2001) GB

(71) Applicant (*for all designated States except US*): **SIEMENS PLC** [GB/GB]; Siemens House, Oldbury, Bracknell, Berkshire RG12 8FZ (GB).

(72) Inventors; and
(75) Inventors/Applicants (*for US only*): **MANSTON, Keith** [GB/GB]; 62 Bluebell Lane, Creekmore, Poole, Dorset BH17 7YU (GB). **COX, Paul** [GB/GB]; 10 Tarn Drive, Creekmoor, Poole, Dorset BH17 7DQ (GB).

(74) Agent: **MORGAN, Marc**; Siemens Shared Services Limited, Siemens House, Oldbury, Bracknell, Berkshire RG12 8FZ (GB).

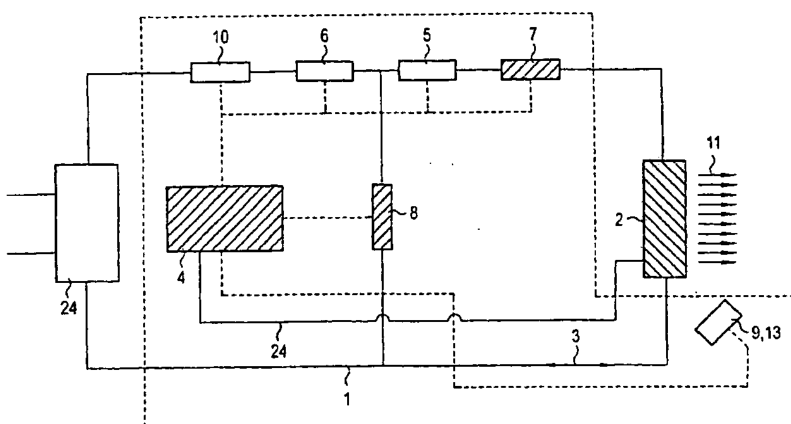
(81) Designated States (*national*): AT, DE, GB, US.

(84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

Published:
— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: ELECTRICAL APPARATUS AND METHOD



(57) Abstract: The invention relates to an apparatus for modifying an electrical current (3) consumed by at least one non-incandescent light emitter (2), in particular an LED array. By use of the electric device (1), the LED array (2) is made compatible with monitor equipment (24) of a traffic signal system normally used in incandescent lamps for failure detection. The apparatus has a control device (4), a first current sensor (5), a current limiter (7), a current sink (8), a failure detecting sensor (9) and an electrical circuit breaker (10). The current limiter (7) and current sink (8) are operated by the control device (4) to provide a current profile (15) with a maximum current value (22), above a pre-determined current threshold (12). Control device (4) operates circuit breaker (10) to remove the current if a failure in the LED array (2) is detected. The invention further provides a traffic signal system and a method for sensing a failure of a non-incandescent light emitter (2) in the traffic light system.

WO 02/074017 A1

ELECTRICAL APPARATUS AND METHOD

The invention relates to electrical apparatus for use with a non incandescent light emitter, for example a light emitting diode, (LED) which may be used in a traffic signal system or the like to replace a incandescent lamp. The invention also relates to a traffic signal system including the apparatus and at least one non-incandescent light emitter as well as monitor equipment. Furthermore, the invention relates to a method for sensing the failure of a non-incandescent light emitter in a traffic lights system.

According to US patent 6,150,771 in traffic signals incandescent lamps are traditionally used to generate the light signal used to control traffic. An alternative to incandescent traffic signals are traffic signals which use light emitting diodes (LEDs). Given the cost of replacing light systems it will be appreciated that it is desirable to upgrade the current light sources in the lights to LEDs rather than to replace the whole lighting system. Replacement of incandescent lamps by LEDs however leads to several technical problems. In particular, LED arrays replacing older incandescent lamps must be compatible with the older incandescent load

switch technology and its associated conflict monitors as described in US patent 6,150,771. The most significant problem according to US patent 6,150,771 is to operate LED arrays to provide an electrical load which is nearly a resistive load which would allow smooth transfer of power from the incoming power line to the traffic signal load. Among other problems addressed by US patent 6,150,771 is that of compatibility arising in the case of failed state of any traffic signal. Traditional monitors sense voltage across a signal and, as such, are only usable with a signal provided by incandescent lamps, unless specific modifications are made to signals provided by other types of light emitters. To overcome this, US 6,150,771 describes an interface circuit which includes an open filament condition circuit (OFC) for indicating an open circuit condition to a conflict monitor when the input voltage is high and the feedback current drops by a certain amount. When this happens the OFC terminates a signal operation and presents such a condition to the conflict monitor as a failed incandescent signal. A failed circuit is introduced which senses the drop in output current due to the LED signal failure. If the output current drops by at least 50% for several seconds the failure circuits shorts a fuse. The blown

fuse then permanently indicates to the conflict monitor a failed signal, that is infinite input impedance.

According to US Patent 6,150,771, the compatibility with a conflict monitor is achieved by certain circuits which sense a drop in the current to the LED and which always change the input current to achieve an almost resistive load. This implies a current source which provides an input current that has an envelope that is substantially the same as the input voltage having a sinusoidal profile.

The present invention is directed to apparatus for modifying an electrical current consumed / drawn by at least one non-incandescent light emitter comprising a control device, a first current sensor for measuring electrical current profile of the non-incandescent light emitter which apparatus comprising a current limiter to limit electrical current drawn by said non-incandescent light emitter, a current sink to increase the electrical current drawn by the non-incandescent light emitter, a failure detecting sensor, circuit breaker for breaking the circuit between a source of the current and the non-incandescent light emitter. The first current sensor, the current limiter, the current sink, the failure detecting sensor and the electrical circuit breaker are connected to the control device. The current

sink and current limiter may also be realised in just one electrical component.

The control device operates the current sink and the current limiter to modify the measured electric current profile to a modified profile having a maximum current value which is above a pre-determined current threshold. The control device causes the circuit breaker to remove the current, if the failure detecting sensor provides a sensor signal indicating that the light emission of that non-incandescent light emitter falls below a predetermined light threshold. The circuit breaker preferably completely disconnects the current source from the non- –incandescent light emitter, if the current falls below the threshold for a certain time period.

With the apparatus, a non-incandescent light emitter is made compatible to existing equipment which allows an incandescent lamp to be replaced by the non-incandescent light emitter. The equipment could include, for example, a lamp monitor facility of a traffic signal system, which monitors whether a lamp is on when it is switched "on". The non-incandescent light emitter may be for example, a light emitting diode (LED) or an array of light emitting diodes and may, or may not, combined

with other electrical elements such as drive circuit arrays. The monitoring of, for example, signal lamps at road intersections which is in some circumstances a legal requirement but at least a desirable one, can be reported and corrected quickly if there is a failure in the light emitter. For lamps of the incandescent type, monitoring can be undertaken by measuring the voltage supply to the lamps and the current that is drawn. A lamp failure is detected when the current drawn falls below a threshold value. Since such lamps present a largely resistive load, the current profile is generally sinusoidal and monitoring of both current and voltage can be undertaken at approximately the peak of the supply voltage waveform. With the electrical apparatus according to the invention it is possible to use LED or other non-incandescent light emitters as substitutes for normally used purely resistive lamps. The complex nature of the LEDs results in a drawn current of a non-sinusoidal manner. The apparatus compensates for the non-sinusoidal current so that a failure in the LEDs can be monitored by existing equipment. The shape of a modified current signal in this case is, preferably, still non-sinusoidal. As an advantage, it is possible to modify the current profile only where it is necessary, and so allow the

existing equipment to monitor the consumed current whilst maintaining the low power consumption of an LED as far as possible.

In accordance with another feature, the failure detector sensor comprises a light detecting sensor for detecting the light emitted by the non-incandescent light emitter. In this way it is possible to directly measure and sense a drop in the light emitted by the non-incandescent light emitter below a value or threshold which indicates a failure of the light emitter.

In accordance with a further feature, the failure detecting sensor comprises a failure circuit, which senses a drop in the output current of the non-incandescent light emitter. The output current corresponds to the light emitted by the non-incandescent light emitter, so that a drop of the output power is a reliable indicator of a failure of the light emitter.

In accordance with an additional feature, the light threshold indicating a failure of the light emitter is about 80% of the value of light emission for normal operations of the non-incandescent light emitter. It is

understood that due to different legal or technical requirements the threshold could be different and even less, for example 50%.

In accordance with yet another feature, the circuit breaker is a replaceable element. A replaceable or removable element may be easily replaced without replacing the whole electrical device or the whole combination of electrical device, light emitter and other devices.

In accordance with yet another feature, the current breaker is a fuse or any other suitable electrical component or device which provides a removal or interruption of the current consumed by the light emitter. In accordance with a yet further feature, the apparatus comprises an electronic circuit including at least one microprocessor. It is also possible to choose for the apparatus any other suitable electrical means. It is also possible to provide a current sensor, current limiter, current sink and/or failure detecting sensor in one microprocessor, one computer or one electronic circuit.

In accordance with another added feature, the apparatus comprises a second current sensor for sensing the modified output current of the non-incandescent light emitter. The second current sensor is connected to the control device and may provide thereto a feedback of the current profile of the electrical arrangement comprisising the apparatus, the non-incandescent light emitter and other electric components. This makes it possible to control and to further adjust the current sink and the current limiter to maintain the desired modified current profile. In any particular implementation, the second current sensor may or may not be included depending on the complexity of the light emitters current profile and the ability of the apparatus to condition the total current being consumed without the feedback that the second current sensor provides.

In accordance with yet another additional feature, the apparatus operates the current limiter and the current sink to modify the current profile to show a substantially flat profile, in particular a plateau like area around the maximum current value. This flat profile portion is located in an area where the current is measured at a number of points. For monitoring the failure of the light emitter, monitor equipment may be used

that normally monitors largely resistive light emitters having a sinusoidal voltage profile and a sinusoidal current profile at points placed in the neighbourhood of the maximum value of the voltage profile. For compatibility with such monitor equipment, the shape of the current profile is so modified that the maximum current value corresponds to the maximum voltage value. Modifying the current profile to show a substantially flat profile, like a plateau around the maximum current value, which means around the maximum voltage value, ensures that as long as the maximum current value is above a certain threshold, the current profile at all measurement points around the maximum value is also above a certain threshold. So the signal characteristic of the non-incandescent light emitter is made compatible with monitor equipment used with incandescent, largely (or purely) resistive lamps.

A modified current profile showing a plateau like area around the maximum current value may have an almost rectangular or an almost trapezoidal shape. Other shapes which show a plateau like area around the maximum current value or a curvature with a sufficient large curvature radius that it forms substantially a plateau may also be used.

The invention also provides a traffic signal system including apparatus in accordance with the earlier aspects comprising at least one non-incandescent light emitter, for example, a light emitting diode (LED) or an array of light emitting diodes, and a lamp monitor. The monitor is connected to the LED for receiving and processing a failure signal. A traffic signal system may include signal lamps at road intersections, at intersections between roads, at pedestrian crossings and railways tracks or at the entrance of garages or other buildings. Those traffic signals systems may include monitor equipment like a traffic controller or a lamp monitor with failure detecting routines based on signals provided by incandescent, largely (or purely) resistive lamps. As mentioned above, the use of apparatus in accordance with the invention makes it possible to substitute incandescent lamps with non-incandescent light emitters, for example, light emitting diodes or arrays of light emitting diodes.

The number of light emitters required will depend on the desired output level and their individual contribution to that level.

In accordance with a further feature, the traffic signal system comprises a further electrical component, for example a drive circuit which is connected to the non-incandescent light emitter. The shape of the current profile of the non-incandescent light emitter and the further electrical component can be modified by the apparatus. Also, more or different, not purely resistive electrical components can be easily catered for.

The invention also provides a method for sensing the failure of an incandescent light emitter in a traffic light system comprising the following steps;

- determining an electrical current profile of the non-incandescent light emitter,
- modifying that current profile to a modified current profile which has a maximum value above a pre-described current threshold detectable by a monitoring equipment situated in the electrical current path of that non-incandescent light emitter,

- providing a failure signal, if the light emission of the incandescent light emitter falls below an predetermined light threshold, and
- in the occurrence of the failure signal interrupting the electrical current.

By using the method, a modified current profile of the non-incandescent light emitter is provided which is compatible with the monitoring equipment for detecting the normal operation of a light emitter. In case of a failure of the light emitter, an interruption of the electrical current occurs and a signal showing a very large input impedance of the system is provided to the monitoring equipment. According to this method, the failure signal indicating an open circuit is provided to the monitor equipment which is the same kind of signal which would be given in case of a failure of a purely resistive incandescent lamp.

Preferably, the current is modified to show a plateau-like area around a maximum value of the supply voltage profile. Equipment which is designed to measure the current supply at measurement points close to

the maximum of a sinusoidal supply voltage profile is also capable of measuring the current of a such modified profile.

Preferably, light emitted by the non-incandescent light emitter is sensed and the failure signal is provided if the light emitted falls below a prescribed threshold.

In accordance with an additional feature of the method, the current through the non-incandescent light emitter is sensed and the failure signal is provided, if the current drops below a value which corresponds to a predetermined current threshold of the light emitter.

Specific embodiments of the invention will now be described, by way of example only, with reference to the drawings in which:

Figure 1 shows a schematic block diagram of apparatus in accordance with the invention connected to a light emitter;

Figure 2 shows a typical incandescent lamp current and voltage profile;

Figure 3 shows by way of example a current profile and a modified current profile of a non-incandescent light emitter; and

Figure 4 shows another example of a current profile and a modified current profile of a non-incandescent light emitter.

For ease of reference, like-features in the drawings bear the same reference numerals.

As shown in figure 1, apparatus for modifying an electric current comprising electrical device 1 is connected to an LED array 2 which serves as a light emitter replacing normally used incandescent lamps in signal lamps or traffic light systems. The electrical device 1 comprises an electrical circuit breaker 10 connected to a second current sensor 6 connected to a first current sensor 5 connected to a current limiter 7, which is connected to the LED array 2. A current sink 8 is connected from a junction between current sensor 6 and current sensor 5 and an end of the LED array 2. The LED array 2 includes a driver not shown.

Furthermore the electrical device 1 comprises a control device 4 to which electrical circuit breaker 10, first current sensor 5, second current sensor 6, current limiter 7 and current sink 8 are connected by a control line shown as a dashed line. A failure detecting sensor 9 comprising a light detecting sensor 13 is located so as to sense light 11 emitted by the LED array 2. The light detecting sensor 13 is connected to the control device 4 by a control line shown as a dashed line. The electrical device 1 is connected to monitor equipment 24, in this case, a traffic controller or lamp monitor of a traffic signal system (not shown).

The first current sensor 5 measures the profile of current 3 which is drawn by the LED array 2 and its drive circuit. The profile is shown as the outline labelled 14 in figures 3 and 4. Using this measured current profile 14, the control device 4 adjusts the current sink 8 to increase the overall current drawn from the monitor equipment 24 and the current limiter 7 to constrain the current 3, so that the original current profile 14 (see fig 2-4) is modified to a modified current profile 15. Thus, as the current profile 14 sensed by sensor 5 crosses a predetermined threshold the current sink 8 is varied to increase the current drawn. As the current flowing through the

array 2 falls back to the threshold, the current sink 8 returns to its original value as the current drawn decreases. The operation is the same for the negative part of the cycle. In this way the overall current profile detected by the monitor 24 is raised to a level that permits it to be effectively monitored. In this embodiment of the electrical device 1, the original current profile 14 is modified to the extent necessary to allow the existing monitor equipment 24 to monitor the modified current profile 15, thus maintaining the lower power consumption properties of LEDs.

The second current sensor 6 provides a feedback of the modified current profile 15 of the LED system 2, allowing the control device 4 to further adjust the current sink 8 and the current limiter 7 to maintain a desired, modified current profile 15. The use of this further component is shown in Fig 4, here the current profile 14 drawn by the LED array and driver is greater than the minimum threshold that can be monitored by the equipment 24. The control device 4 controls the limiter 7 to limit the current drawn by the LED array 2 to maintain the plateau 16 of the total current drawn profile 15.

It is clear that in any particular implementation of the electrical device 1, the second current sensor 6 may or may not be included depending on the complexity of the LED systems current profile 14 and the ability of the control device 4 to condition the modified current profile 15 without this feedback.

The light detecting sensor 13 detects the light 11 emitted by the LED array 2 for assessment by the control device 4. Should the LED array's output fall below a defined threshold, the control device 4 totally extinguishes the LED array 2 by operating the electrical circuit breaker 10 (in this case a fuse). The result is that current 3 reduces to zero allowing the monitor equipment 24 to detect the failure and take appropriate action. In this way, the LED array 2 mimics the behaviour of an incandescent lamp when a lamp blows and the current falls to zero.

Figure 2 shows a typical incandescent lamp current 21 and voltage profile 17. Both supply the voltage waveform and lamp current waveform have a sinusoidal shape with the same phase angle. In this case the maximum value of the supply voltage waveform 18 and lamp current measured over time coincide. Around these maximum values of supply

voltage 18 and lamp current (either positive or negative maximum values) a number of measurement points 19, 20 are provided for detecting voltage and current. When measuring the lamp current, information is provided whether a failure of the lamp occurs or not. If the signal lamp should be on, then the current value around the maximum will be flowing and have a certain value. If no current is measured at the measurement points 20 then a lamp failure condition is indicated.

Figure 3 shows an example of supply voltage waveform 17 and non-modified electrical current profile 14 of the LED array 2 having a large number of peaks and troughs superimposed on a generally sinusoidal waveform. This original profile 14 shows a far more complex behaviour than the sinusoidal current profile 21 of an incandescent lamp according to figure 2. The monitor equipment 24 of a traffic signal system is designed for use with incandescent lamps and thus expects a relatively smooth sinusoidal waveform having a substantial amplitude and thus by using the electrical device the current profile 14 is modified to modified current profile 15. This modified current profile 15 shows an almost rectangular shape with a plateau like area 16 above a certain pre-determined current

threshold 12. The plateau like area 16 is provided where the current measurement points 20 of the monitor equipment 24 are located, that is to say about the peak of the applied voltage. So the modified current 15 shows a maximum current value 22 which is above the pre-determined current threshold 12. The current signal profile 15 consumed by the LED array 2 and controlled by the control device 4 is therefore detectable by already installed monitoring equipment 24. As soon as a failure of the LED array 2 is detected, the current through the LED array 2 is interrupted and a failure signal of the same type as it is provided by incandescent lamp is provided to the monitor equipment 24.

Figure 4 shows another example of a modified profile 15 having a plateau like area 16 above a predetermined current threshold 12. In figure 3, the original electric current profile 14 has a maximum current value below the pre-described current threshold 12. The original electrical current profile 14 of figure 4 has a maximum value which is above the current threshold 12 but placed outside the area in which the current measurement points 20 are located.

The current profile is modified by the apparatus to provide a modified current profile having a measurable plateau 16 centred about the peak of the voltage and hence lying within the measurement points.

In an alternative embodiment of the invention, an additional control line 24 is provided between the control device 4 and the LED array 2. The control device 4 places a control signal on this line in response to which the LED array 2 is driven at different light output levels. The light level is varied in the following manner. When the traffic light is switched "on" the control device 4 gradually increases the light level produced by the LED array 2. Similarly when the traffic light is to be switched off, the control device 4 gradually decreases the light level produced by the LED array 2.

Gradually increasing or decreasing the light intensity has a number of beneficial effects. Firstly, the light more closely mimics the performance of an incandescent lamp to a person viewing the light. Secondly, it is believed that a gradual variation may have a positive effect on the very important issues of safety. In the case of a road user, for example a rapid light change can have a startling effect. As a user

approaches a set of traffic lights, the user will not only look at the lights but rear and side mirrors, pavements other road junctions. All these actions take place in a matter of split-seconds in an instinctive manner. Thus, it will be appreciated that a light that instantaneously switches may be perceived as a change which has been missed while attention was given elsewhere. This may have the effect of startling the driver into applying the vehicle's brakes more harshly than is warranted. A skid or even an accident may be caused by this action. Another example, of startling the user into an unwarranted action is the situation where the user is waiting at lights for their change but this time the effect may be to excite the driver into starting off more rapidly then is warranted.

A further, more subtle effect, is that drivers when subjected to rapidly changing traffic lights may become stressed or confused. Stress or confusion can cause erratic driving again having an impact on safety.

Claims:

1. Apparatus (1) for modifying an electrical current (3) drawn by at least one non-incandescent light emitter (2) which apparatus comprising

– a control device (4)

– a first current sensor (5) for measuring the electrical current profile (14) of the non-incandescent light emitter (2)

– a current limiter (7) to constrain the electrical current (3) drawn by the non-incandescent light emitter (2)

– a current sink (8) to increase the electrical current (3) consumed by the non-incandescent light emitter (2)

– a failure detecting sensor (9)

– an electrical circuit breaker (10) for removing the electrical current (3) drawn by the non-incandescent light emitter (2)

wherein

- the first current sensor (5), said current limiter (7), the current sink (8) , the failure detecting sensor (9) and the electrical circuit breaker (10) are connected to the control device (4),

- the control device (4) operates the current sink (8) and the current limiter (7) to modify the measured electrical current profile (14) to a modified profile (15) having a maximum current value (22) which is above a predetermined current threshold (12)
- the control device (4) causes the circuit breaker (10) to remove the current, if the failure detecting sensor (9) provides a sensor signal indicating that the light emission of the non-incandescent light emitter (2) falls below a predetermined light threshold.

2. Apparatus (1) according to claim 1, wherein the failure detecting sensor (9) comprises a light detecting sensor (13) for detecting the light emitted by the non-incandescent light emitter (2).

3. Apparatus according to claim 1, wherein the failure detecting sensor (9) comprises a failure circuit, which senses a drop in the consumed current (3) of the non-incandescent light emitter (2).

4. Apparatus according to claim 2 or 3, wherein the light threshold is 80%

of the value of light emission for normal operation of the non-incandescent light emitter (2).

5. Apparatus according to any of the preceding claims, wherein the circuit breaker (10) is a replaceable element.

6. Apparatus according to any of the preceding claims, wherein the circuit breaker (10) is a fuse.

7. Apparatus according to any of the preceding claims, wherein the control device (4) is an electronic circuit including at least one microprocessor.

8. Apparatus according to any of the preceding claims, comprising a second current sensor (6) for sensing the modified consumed current (15) of the non-incandescent light emitter (2) and being connected to the control device (4).

9. Apparatus according to any of the preceding claims, wherein the control device (4) operates the current limiter (7) and the current sink (8) to modify the current profile (14) to show a substantially plateau like area around the maximum current value (22).

10. Apparatus according to any of the preceding claims wherein said modified current profile (15) has substantially an almost rectangular or substantially an almost trapezoidal shape.

11. A traffic signal system comprising apparatus according to any of the preceding claims, further comprising at least one non-incandescent light emitter (2) and a monitoring equipment, which is connected to the electrical device (1) for receiving and processing a lamp failure signal.

12. Traffic signal system according to claim 10, wherein the at least one non-incandescent light emitter (2) comprises a light emitting diode (LED).

13. A traffic signal system according to claim 12 wherein the at least one non-incandescent light emitter (2) comprises a number of LEDs in the range 8 to 350 LEDs.

14. Traffic signal system according to anyone of claims 11 to 13, wherein the at least one non-incandescent light emitter (2) is connected to a drive circuit array.

15. A method for sensing the failure of a non-incandescent light emitter (2) in a traffic light system comprising the following steps

- determining an electrical current profile (14) of the non-incandescent light emitter (2),

– modifying said current profile (14) to a modified current profile (15), which has a maximum value above a pre-determined current threshold, detectable by a monitoring equipment (24) situated in the electrical current path.

– providing a failure signal, if the light emission of the non-incandescent light emitter (2) falls below a predetermined light threshold,

- in the occurrence of the failure signal, interrupting the electrical current(3).

16. Method according to claim 15, in which the current profile (14) is modified to show a substantially plateau like area (16) around a maximum value (18) of the supply voltage profile (17).

17. Method according to claim 15 or 16 in which light (11) emitted by the non-incandescent light emitter (2) is sensed and the failure signal is provided, if the light (11) emitted falls under a predetermined threshold.

18. Method according to claim 15 or 16, in which the current (3) through the non-incandescent light emitter (2) is sensed and the failure signal is provided, if the current (3) drops under a value which corresponds to a predetermined threshold of the light (11) emitted.

19. Apparatus for modifying an electrical current in use drawn from a current source which current, at least in part, being used to power at least one non-incandescent light emiitter which apparatus comprising:

a current sensor for sensing that current drawn by the non-incandescent light emitter and to produce a sensed current output signal;

a controller responsive to the sensed current output signal to produce a control signal ;

a current modifier responsive to the control signal to modify the electrical current , in use, drawn from the current source.

20. Apparatus as claimed in claim 19 wherein the current modifier comprises a current sink.

21. Apparatus as claimed in claim 19 or 20 wherein the current modifier comprises a current limiter.

22. Apparatus as claimed in any one of claims 19 to 21 wherein the current modifier modifies the electrical current drawn from the current source to maintain it at a predetermined level for a predetermined time.

23. Apparatus as claimed in claim 22 wherein the predetermined time coincides, at least in part, with a measurement time of a monitor for in use monitoring the current drawn.

24. Apparatus for controlling current to a non-incandescent light source which apparatus comprising:

a detector for detecting the light output of the non-incandescent light source and to provide a detector output; and

circuit breaker means responsive to the detector output to break a connection between a current source and the non-incandescent light source.

25. Signaling apparatus comprising a non-incandescent light source having an on-state and an off-side; and a controller controlling the light source to vary its intensity over time when the light source is switched from one state to the other.

26. A signal system including apparatus as claimed in claims 19 to 25.

FIG 1

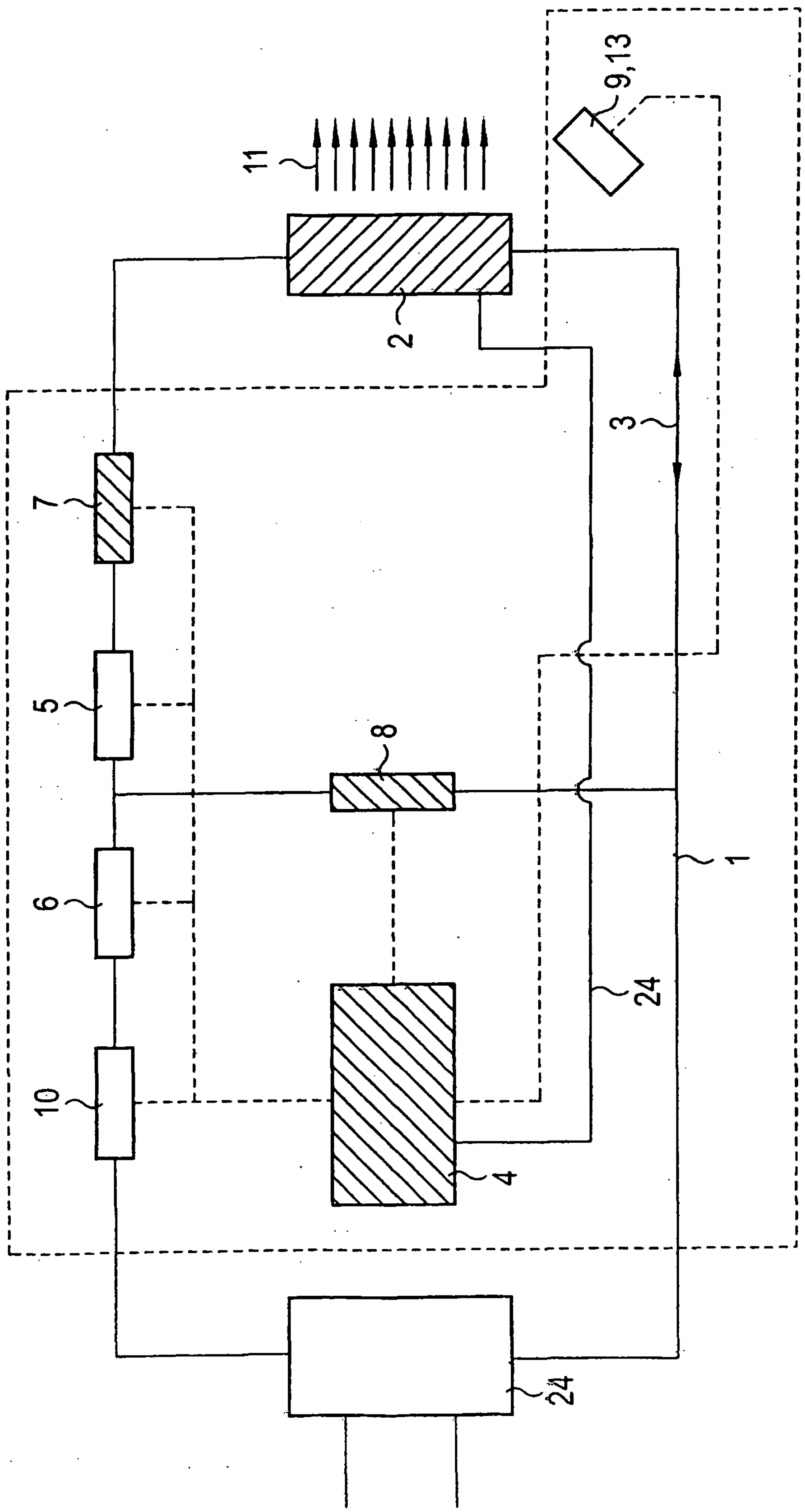


FIG 2

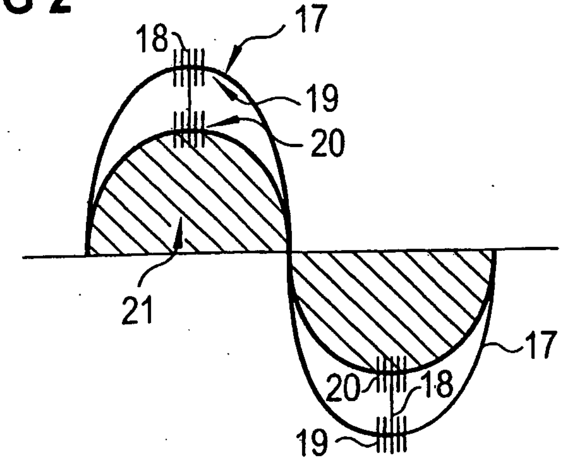


FIG 3

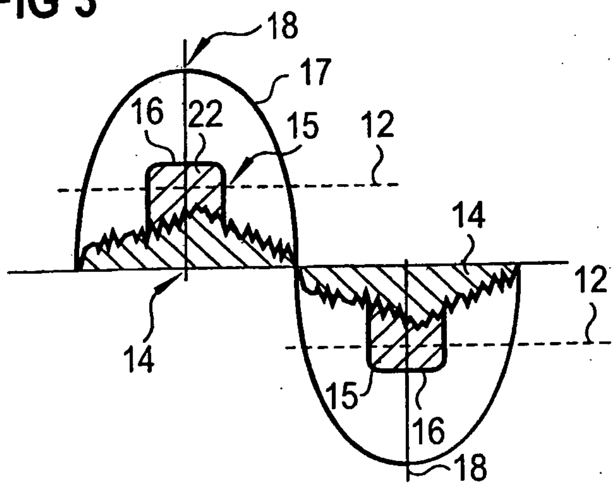
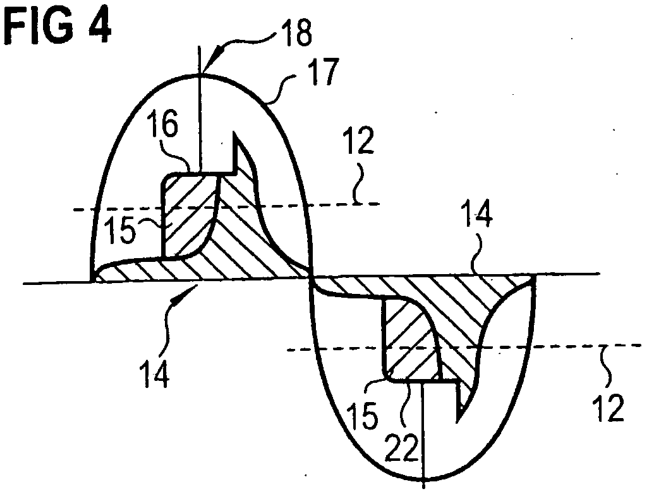


FIG 4



INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 02/00963

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H05B33/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 118 259 A (BUCKS MARCEL J M ET AL) 12 September 2000 (2000-09-12)	1-8, 11-15, 17-23, 25,26
A	column 1, line 48 -column 2, line 3 column 3, line 37 -column 4, line 26; figures 1-3	9,10,16
X	FR 2 724 749 A (SOFRELA SA) 22 March 1996 (1996-03-22)	1-8, 11-15, 17-23, 25,26
A	abstract; figures 1,2	9,10,16

-/--

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
24 June 2002	01/07/2002
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Speiser, P

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 02/00963

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 49872 A (BEARFIELD GEORGE JOSEPH ;WAREING JAMES IAN (GB); ROBINSON MAX (GB)) 5 November 1998 (1998-11-05) page 10, line 26 -page 11, line 6 abstract; figure 4	24-26
X	US 6 150 771 A (PERRY BRADFORD J) 21 November 2000 (2000-11-21) cited in the application abstract; figure 11	19,25
X	CA 2 225 005 A (ECOLUX) 17 June 1999 (1999-06-17)	19,25
A	abstract; figure 1	1,11,15

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 02/00963

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 6118259	A	12-09-2000	WO	9956504 A1	04-11-1999
FR 2724749	A	22-03-1996	FR	2724749 A1	22-03-1996
WO 9849872	A	05-11-1998	AU	7221098 A	24-11-1998
			EP	0979597 A1	16-02-2000
			WO	9849872 A1	05-11-1998
US 6150771	A	21-11-2000	NONE		
CA 2225005	A		NONE		